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Influence of duration and level of feed restriction on blood parameters, carcass characteristics and feed cost of marshall broiler chickens

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Target Audience: *Farmers, Scientists, Researchers, Students*

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Abstract

Two hundred and sixteen unsexed 14 days-old Marshall broiler chicks were used in a 3×3 factorial experimental layout to test the effect of restricting feed intake of birds to 0%, 20% and 40% levels for 2, 4 and 6 weeks. The experiment lasted for 42 days. Data were collected on blood and serum profile, carcass characteristics, while the cost-benefit analysis was calculated. Data obtained were subjected to a 2-way analysis of variance. Results showed that duration and level of restriction had significant effect (P<0.05) on blood parameters except red blood cell while serum cholesterol values decreased significantly (P<0.05) with increasing level and duration of restriction. Abdominal fat decreased with increasing duration and level of restriction with birds on 40% level and 6 weeks duration of restriction having the lowest fat content (0.20%). As level and duration of feed restriction increased, feed cost/ kg reduced. Birds restricted at 40% level for 2, 4 and 6 weeks durations respectively had better cost benefit than birds restricted at 0 and 20% levels for 2, 4 and 6 weeks durations. It can be concluded that lower abdominal fat, cholesterol and better cost benefit was achieved in birds restricted at 40% for 6 weeks. The diet therefore produced lean meat at reduced cost which can be of advantage to the producer.

Key Words: *abdominal fat; blood; cholesterol; carcass; savings*

Description of Problem

One of the objectives of poultry production is to produce proteins of high quality with minimum cost in the shortest possible time. Increased costs of feeding and early fat deposit are few of the problems of poultry farmers (1). Feeding strategies in growing broiler chickens should be aimed at optimising lean carcass tissue, feed conversion ratio (FCR) and body weight gain (2; 3). Birds selected for fast growth (commercial broilers) suffer from leg disorders, organ failure and heart disease. At six weeks of age, broiler chickens have much difficulty supporting their abnormally heavy bodies as they spend 76 to 86 % of their time laying down (4). They may suffer from respiratory diseases, big liver and spleen disease and sudden death syndrome (5;6;7). This has stimulated interest in developing management procedures to increase feed efficiency, reduce abdominal-fat deposition in broiler chickens and trend towards leaner carcasses (8). Many scientists have explored ways to decrease the abdominal and/or carcass fat in poultry. Previous studies have shown that feed restriction could decrease fat content and increase protein deposition in carcasses, thus resulting in the improved carcass composition (9; 10). Cholesterol is

used to build cell membranes and hormones, and the excess cholesterol circulation in the bloodstream can clog bleed vessels and increase the risk for heart disease and stroke. Blood measurements give information about animal health and metabolism though (11) and (12) did not find effects of feed restriction on blood biochemical parameters there is a need for care should be taken to conduct restriction studies that will not produce adverse effects on the health and physiological status of the birds hence this research.

This study was aimed at identifying the duration and level of restriction that will bring about lean carcass tissue and cost benefit in broiler production.

Materials and Methods

Experimental site

The study was carried out at the Directorate of University Farms (DUFARMS), Federal University of Agriculture (FUNAAB), Abeokuta, Ogun State, Nigeria

Experimental birds and management

A total of two hundred and sixteen (216) day old Marshall broiler chicks purchased from a reputable hatchery were used for the study. On arrival, they were given water containing glucose as anti-stress before feeding. The chicks were brooded for two weeks using charcoal pot. At the beginning of the experiment at day 15, the birds were randomly distributed into nine treatments with 3 replicates of 8 birds per replicate. Daily routine management were carried out such as supply of clean water, feed, observing for sick birds, checking for mortalities and appropriate record keeping. Administration of vaccines, antibiotics and vitamin supplement was given when necessary. The experiment lasted for 42 days.

Experimental diet

There were three levels of quantitative feed restriction -0-*Ad libitum*, 20 and 40% (100, 80 and 60% of *ad libitum* was administered) and three feed restriction durations of 2, 4 and 6 weeks (followed by a realimentation period of 4, 2 and 0 weeks) respectively. The birds were distributed randomly into nine treatments. Weekly feed supply of each chick was predicated on the findings of (13). The birds were fed a corn-soya based diet having 21.74CP and 2850.75ME. Water was provided *ad libitum.*

Experimental design

The experimental design used was 3×3 factorial design. There were two factors of feed restriction. Duration of restriction was at three periods (2, 4 and 6 weeks) while level of restriction was at three levels (0, 20 and 40% of *ad libitum*).

Data collection

Haematological and biochemical components determination

At the end of the feeding period (42 days) the chickens were selected and blood samples were collected from two birds per replicate for haematological and serum parameters. About 2.5mls of blood was collected into sample bottles containing ethylene diamine tetra acetic acid (EDTA). This was used to determine the haematological parameters such as packed cell volume (PCV), haemoglobin concentration (Hb), white blood cell (WBC), red blood cell (RBC) following standard procedures described by (14). Another 2.5mls of blood was collected into sample bottles without anticoagulant for the determination of serum metabolites- total serum protein (TP), glucose and cholesterol (14).

Table 1: Main effect of duration and level of feed restriction on haematological and serum biochemical parameters of Marshall broiler chickens

	Duration of feed restriction (weeks)				Level of feed restriction (%)			
Parameters	**2**	**4**	**6**	**SEM**	**0**	**20**	**40**	**SEM**
Packed Cell Volume (%)	23.44	23.77	23.33	0.58	22.33^{b}	24.89^{a}	23.33^{ab}	0.58
Haemoglobin (g/dL)	8.26^{a}	7.89^{ab}	7.80^{b}	0.13	7.43^{c}	8.64^{a}	7.87^{b}	0.13
White Blood Cell(cumm^{2})×103	30.39	30.11	30.24	0.44	29.29^{b}	30.53^{ab}	30.92^{a}	0.44
Red Blood Cell (x1012/L)	2.29	2.24	2.21	0.07	2.23	2.33	2.17	0.07
Glucose (mg/dL)	238.66^{a}	224.70^{c}	231.84^{b}	1.64	227.96^{b}	260.47^{a}	266.78^{a}	1.64
Serum Total Protein (g/L)	40.19^{b}	43.96^{a}	40.83^{b}	0.53	40.24^{b}	46.17^{a}	38.57^{c}	0.53
Cholesterol (mg/dL)	185.81^{a}	177.92^{b}	176.14^{b}	0.94	204.86^{a}	176.11^{b}	158.91^{c}	0.94

^{a,b,c}: Means in the same row not sharing common superscript are significantly different (P<0.05)
SEM: Standard error mean

Table 2: Interactive effect of duration and level of feed restriction on haematological and serum biochemical parameters of Marshall broiler chickens

PARAMETER	DURATION	LEVEL			SEM
		0	**20**	**40**	
Packed Cell Volume (%)	2	21.33^{c}	26.67^{a}	22.33^{bc}	0.58
	4	22.33^{bc}	23.33^{bc}	25.67^{ab}	0.74
	6	23.33^{bc}	24.66^{abc}	22.00^{c}	1.01
Haemoglobin (g/dL)	2	7.30^{d}	9.90^{a}	7.57^{d}	0.13
	4	7.37^{d}	7.70^{cd}	8.60^{b}	0.17
	6	7.63^{cd}	8.30^{bc}	7.43^{d}	0.23
White Blood Cell(cumm^{2})×10^{3}	2	29.11^{c}	28.75^{c}	33.30^{a}	0.44
	4	28.71^{c}	32.11^{ab}	29.31^{c}	0.65
	6	29.85^{bc}	30.74^{bc}	30.15^{bc}	0.75
Red Blood Cell (x10^{2}/L)	2	2.33	3.37	2.14	0.07
	4	2.19	2.29	2.22	0.09
	6	2.17	2.29	2.16	0.13
Glucose (mg/dL)	2	235.03^{c}	269.00^{bc}	311.93^{a}	1.64
	4	232.70^{c}	273.00^{b}	208.40^{d}	2.04
	6	216.13^{d}	299.40^{ab}	280.00^{b}	2.85
Serum Total Protein (g/L)	2	39.07^{c}	42.90^{b}	38.62^{c}	0.53
	4	40.80^{bc}	56.27^{a}	34.80^{d}	0.75
	6	40.87^{bc}	39.33^{c}	42.30^{b}	0.92
Cholesterol (mg/dL)	2	193.87^{b}	178.83^{d}	155.73^{f}	0.94
	4	231.97^{a}	166.90^{e}	158.57^{f}	1.32
	6	190.93^{bc}	188.73^{c}	154.10^{f}	1.63

^{a,b,c,d}: Means in the same row not sharing common superscript are significantly different (P<0.05)
SEM: Standard error mean

Carcass characteristics

At the end of the experiment (42 days), 6 birds per treatment (2 birds per replicate) were randomly selected for carcass evaluation. Birds were deprived of feed overnight to avoid gut fill, weighed, and sacrificed by slitting the throat. Complete bleeding was ensured and the feathers

removed. The carcasses were weighed after removing heads, shanks and viscera to determine the dressing percentage of carcass weight. The carcasses were cut into retail cut-up parts (breast, wings, back, drumstick, neck) weighed and their weights were expressed as a percentage of dressed weight.

Cost benefit determination

Cost of feed was determined by calculating the cost of feeding each treatment group during the experimental period. Cost benefit of production, i.e. feed cost/kg, cost of feed consumed/day, cost of bird/ kg/ liveweight and feed cost reduction were calculated.

Statistical analysis

All data collected were subjected to a two-way analysis of variance in 3×3 factorial experimental layout using a statistical package (15). Significant (p<0.05) differences among variables were separated using Duncan's Multiple Range Test. (16).

Table 3: Main effect of duration and level of feed restriction on carcass characteristics of Marshall broilers

	Duration of feed restriction (weeks)				Level of feed restriction (%)			
Parameters	**2**	**4**	**6**	**SEM**	**0**	**20**	**40**	**SEM**
Live weight (g)	1935.56[a]	1828.22[ab]	1723.33[b]	45.79	2085.78[a]	1697.33[b]	1759.00[b]	45.79
Dressed weight (g)	1783.33[a]	1686.67[ab]	1576.67[b]	47.25	1930.00[a]	1555.56[b]	1561.11[b]	47.26
Dressing percentage (%)	76.73	77.35	77.11	1.08	77.00	77.48	76.71	1.079
Abdominal fat (%)	0.47[b]	0.54[a]	0.34[c]	0.07	0.52[a]	0.50[a]	0.33[b]	0.07
Retail cut-up parts (% dressed weights):								
Breast	23.40	24.96	25.75	1.00	25.02	23.98	25.12	1.00
Thighs	13.61	12.77	13.97	0.50	13.12	13.75	13.50	0.50
Drumstick	11.77	12.25	11.48	0.56	11.76	12.01	11.73	0.56
Wings	9.37[a]	7.90[b]	8.48[ab]	0.38	7.36[b]	9.55[a]	8.84[a]	0.38
Back	15.97	15.51	14.94	0.75	15.83	15.42	15.17	0.75
Shanks	5.10	4.68	5.05	0.18	4.15	4.14	4.72	0.21
Head	2.99[b]	3.09[ab]	3.30[a]	0.08	4.77[b]	5.32[a]	4.75[b]	0.18
Visceral organs (% dressed weights):								
Heart	0.46	0.47	0.52	0.03	0.46	0.47	0.52	0.03
Liver	1.79	1.76	1.79	0.05	1.67[b]	1.82[ab]	1.86[a]	0.05
Empty gizzard	2.17	2.22	2.12	0.05	2.02[b]	2.23[a]	2.26[a]	0.05

[ab]: Means in the same row not sharing common superscript are significantly different (P<0.05)
SEM: Standard error mean

Results and Discussion

In this study, PCV and Hb of the birds were highest during 2 weeks duration and at 20% level of restriction. The values (P>0.05) observed for RBC varied across the treatments and the highest value was recorded in birds restricted for 2 weeks duration at 20%. RBC values were along the normal range as expressed in (17) who stated 2.23 to 2.58. WBC recorded the highest value for 2 duration weeks at 40% level of restriction. (20) reported differences in PCV arising from varying levels of feed restriction. (20) also reported significant (p<0.05) differences and higher values in Hb and RBC in restricted birds.

Table 4: Interactive effect of duration and level of feed restriction on carcass characteristics of Marshall broiler chickens

PARAMETER	DURATION	LEVEL			SEM
		0	20	40	
Live weight (g)	2	2135.30^{a}	1883.70^{ab}	1826.70^{ab}	47.25
	4	2087.30^{a}	1739.30^{b}	1658.00^{bc}	65.76
	6	2079.70^{a}	1435.00^{c}	1637.60^{bc}	79.31
Abdominal fat (%)	2	0.40^{ab}	0.41^{ab}	0.59^{a}	0.07
	4	0.59^{a}	0.66^{a}	0.37^{ab}	0.10
	6	0.57^{a}	0.41^{ab}	0.20^{b}	0.13
Retail cut-up parts (% dressed weights):					
Breast	2	22.47	23.21	24.53	1.00
	4	25.27	23.32	26.29	1.09
	6	27.32	25.4	24.54	1.74
Thighs	2	13.26	14.49	13.08	0.5
	4	12.49	12.63	13.21	0.65
	6	13.61	14.11	14.21	0.88
Drumstick	2	12.37	10.97	11.97	0.56
	4	11.56	13.41	11.77	0.75
	6	11.35	11.65	11.44	0.97
Wings	2	8.41^{bc}	10.95^{a}	8.75^{bc}	0.38
	4	6.76^{c}	8.14^{bc}	8.81^{abc}	0.45
	6	6.92^{c}	9.56^{ab}	8.95^{abc}	0.67
Back	2	16.29	15.21	15.91	0.75
	4	15.19	15.77	15.57	1.04
	6	16.01	14.78	14.02	1.31
Neck	2	4.83^{ab}	4.38^{ab}	4.21^{ab}	0.21
	4	3.78^{b}	3.96^{ab}	5.14^{a}	0.23
	6	3.84^{b}	4.09^{ab}	4.82^{ab}	0.37
Shank	2	4.92^{ab}	5.56^{a}	4.83^{ab}	0.18
	4	4.62^{ab}	5.13^{ab}	4.29^{b}	0.16
	6	4.76^{ab}	5.25^{ab}	5.12^{ab}	0.31
Head	2	2.92^{c}	3.01^{bc}	3.05^{abc}	0.08
	4	3.00^{bc}	3.03^{bc}	3.23^{abc}	0.13
	6	2.89^{c}	3.49^{ab}	3.52^{a}	0.15
Visceral organs (% dressed weights):					
Heart	2	0.45	0.39	0.52	0.03
	4	0.45	0.43	0.52	0.02
	6	0.47	0.57	0.51	0.05
Liver	2	1.68^{b}	1.69^{b}	2.02^{a}	0.05
	4	1.62^{b}	1.87^{ab}	1.78^{ab}	0.07
	6	1.71^{ab}	1.90^{ab}	1.77^{ab}	0.09
Empty gizzard	2	2.09^{bc}	2.31^{ab}	2.11^{bc}	0.05
	4	1.92^{c}	2.28^{ab}	2.47^{a}	0.06
	6	2.06^{bc}	2.12^{bc}	2.19^{abc}	0.1

^{ab}: Means in the same row not sharing common superscript are significantly different (P<0.05) SEM: Standard error mean

Glucose is a major metabolite that is closely related to the sustainability of energy supply for the implementation of the physiological and biochemical functions in the body (18). Glucose, total serum protein and cholesterol varied significantly (P<0.05) across the duration of restriction, this is similar to results reported by (19). Birds on 2 weeks restriction recorded the highest (P<0.05) glucose concentration. The serum glucose of

birds on 20 and 40% levels of restriction recorded the highest (P<0.05) glucose values compared to the unrestricted birds. Glucose is a main carbohydrate needed as a precursor for the energy citric acid cycle. Typically, broiler glucose level is higher than mammals, ranging between 180-250 mg/dL (18) However, birds restricted for 4 weeks at 40% level of restriction had a lower blood glucose value compared to other treatments in the interaction. Total serum protein was highest in birds restricted for 4 weeks at 20%. Serum cholesterol was significantly higher (P<0.05) at *ad libitum* and lowest at 40% level of feed restriction. The values followed the same trend for each durations in which cholesterol reduced as the level of feed restriction increased. (21) observed that a prolonged energy restriction decreased cholesterol content of the blood with a concomitant reduction in the abdominal fat percentage.

Table 5: Effect of level and duration of feed restriction on cost benefit of Marshall broiler chickens

PARAMETER	DURATION	LEVEL		
		0	20	40
Cost of chicks (N)	2	3360	3360	3360
	4	3360	3360	3360
	6	3360	3360	3360
Feed consumed (kg/bird)	2	4.043	4.248	4.229
	4	3.94	3.781	3.414
	6	3.834	3.342	2.565
Feed price/kg (N)	2	72	72	72
	4	72	72	72
	6	72	72	72
Total feed cost (₦)	2	6986	7340	7307
	4	6808	6533	5899
	6	6625	5774	4432
Labour and Drugs (N)	2	3000	3000	3000
	4	3000	3000	3000
	6	3000	3000	3000
Total cost (₦)	2	13346	13700	13667
	4	13168	12893	12259
	6	12985	12134	10792

The interaction also showed that serum cholesterol in broilers fed *ad libitum* tended to be higher than the restricted birds. (11) also reported that early restriction decreased cholesterol in the blood but reported an increase in abdominal fat at 63 days of age.

In this study, highest (P<0.05) liver and empty gizzard values of 1.86% and 2.26% were recorded for broilers at 40% level of feed restriction. Broiler chickens on 20 and 40% levels of dietary restriction had similar gizzard weights. Liver, abdominal fat pad and gizzard were affected by feed restriction while thighs, drumsticks, wings, breast meat, intestine and heart were not affected. Abdominal fat decreased with increasing levels of restriction with birds restricted at 40% had the lowest value (0.33%). This might be due to fat mobilization for energy supply and abdominal fat might be mobilized

more easily during a fasting period. Wings and heart weights were significantly higher in the restricted birds. Reducing the growth by feed restriction allowed heart growth to remain in phase with body growth. (20) and (23) reported that the growth of breast is inhibited during restriction. A reduction in abdominal fat content with concomitant reduction in body weight were found by (9) and (24). Other investigators have reported reductions in abdominal fat pad due to early life feed restriction but a small reduction in final body weight (6). (25) reported that feed efficiency was improved, but the amount of abdominal fat in male broilers was increased. Feed-restricted birds have been shown to have lower carcass fat content at market age than birds fed *ad libitum* (8). (9) and (26) did not find changes in carcass composition of birds after feed restriction conditions; however, (27; 28) and (24) reported a decrease in fat pad on birds restricted from 6 to 12 days of age, without adverse effects on growth. The same effect of restriction on the amount of carcass fat was found by (27); but with lower body weight gain in relation to the *ad libitum* birds, perhaps due to the restriction severity (70% of the *ad libitum* feed intake). (29) reported a larger abdominal fat deposition in the carcass of restricted birds after refeeding. According to (30), fat pad is more directly influenced by nutrition than total carcass fat. Most of these studies reported improved feed efficiency and a reduction of body fat and abdominal fat, but with final body weight somewhat reduced. There are exceptions; for example (31) found no difference in overall feed efficiency between restricted and full-fed broilers. (32) also showed that feed-restricted birds usually had a smaller abdominal fat pad. Feed restriction brought about the reduction of abdominal fat which is line with the reports of (22); (33) and (34). However, this study proves that abdominal fat is a perfect indicator to estimate carcass fat content.

Feed restriction affected the live weight of broiler chickens at 56 days of age. Chickens on 20% restriction attained little compensation in live weight but did not achieve up to the control birds while those on 40% restriction did not. Thus, 20% restriction was beneficial in terms of saving feed. It may, therefore, be a useful tool to reduce the cost of starter feed, without any adverse effect on the final body weight of the chickens. However, generally from this study, total feed cost per bird was reduced by increasing durations and levels of feed restriction.

Conclusion and Applications

The study established that:

1. Feed restriction had effect on haematological and serum biochemical parameters with emphasis on serum cholesterol which was reduced with increase in feed restriction.
2. Dressing percentage, liver and gizzard yields were affected by feed restriction while total feed cost was reduced with increasing severity of feed restriction from 2 to 6 weeks.
3. Hence, restricting feed at 40% for 6 weeks is recommended based on lower abdominal fat and blood cholesterol.
4. As a producer, cost is saved while producing lean healthy meat for consumers.

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